

**A CONTRIBUTION TO THE BIOLOGY OF THE OMMASTREPHID SQUID  
*MARTIALIA HYADESI* (ROCHEBRUNE AND MABILLE, 1889)  
FROM THE SOUTH-WEST ATLANTIC**

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Updated knowledge on the distribution and biology of the ommastrephid squid *Martialia hyadesi* in the South-West Atlantic Ocean is presented. Although the species has an Antarctic circumpolar distribution, its most frequent area of appearance is in the South-West Atlantic, where commercial catches have been made. During the 1995 *Illex argentinus* fishing season, 852 tons of *Martialia hyadesi* were caught, the largest catches in recent years. The species was captured on the outer shelf and slope, between 38 and 50°S, from March until June. Catches of up to 40 tons per day were obtained in the area between 45 and 48°S (April–June), where surface temperatures ranged between 7 and 9°C. The squid caught were adults (221–375 mm mantle length *ML*), 70% of the males were mature and 90% of the females were immature. Statolith readings, assuming daily formation of increments, showed that most had hatched during the months October and November. According to stomach content analysis, fish represented 43.9% of the food consumed (90% myctophids), squid 36.6% (70% cannibalism on small juveniles) and zooplankton 19.5%. Juveniles of the same species were caught on the Patagonian slope and in the adjacent oceanic region during spring of 1988 and 1989, most of them in waters of the Malvinas Current (5–7°C). The sizes of those juveniles ranged between 15 and 81 mm *ML* and the ages (based on statolith increments) between 137 and 150 days, indicating that they had hatched during April.

*Martialia hyadesi* is considered to be an Antarctic circumpolar species, although the widest and most frequent area of appearance is in the South-West Atlantic Ocean. This is also the only region where commercial catches have been made (Rodhouse 1991). In this area the species has been reported, longitudinally, from Cape Horn (67°W; Rochebrune and Mabile 1889) up to the west of the Shag Rocks (47°W; Rodhouse and Yeatman 1990), and latitudinally, between Cape Horn (56°S) and 37°S (Nesis 1987, Brunetti *et al.* 1990). Adults have occasionally been caught in the Indian Ocean (Kerguelen Islands; Piatkowski *et al.* 1991) and in the Pacific Ocean (Macquarie Island; O'Sullivan *et al.* 1983). Juveniles have been recorded north of this last position, between Auckland Island and south-east of New Zealand (Uozumi *et al.* 1991), and in the diet of *Allothenus fallai* caught in the south-eastern Pacific Ocean (44–48°S, 81–118°W; Yatsu 1995).

This paper presents information on the distribution and the biology of juveniles and adults of the species obtained either from commercial or research vessels in the area off Argentina.

**MATERIAL AND METHODS**

Analysis of the 1995 fishing season off Argentina was made using information on catches (kg) and effort

(hours of fishing and number of lines used) provided by the locally based jigger fleet. The catch per unit effort (*cpue*) was estimated as follows:

$$cpue = \text{catch (kg)} \cdot \text{line-h}^{-1} \quad .$$

Sea surface temperature was also available from these boats.

In all, 294 squid were sampled from the catches obtained by three commercial jiggling vessels in the approximate area 45–47°S, 58°W during the months of May and June. The following data were recorded: mantle length (*ML*, mm), total mass (g), sex, maturity stage (eight-point scale, Brunetti 1990), nidamental gland mass (g), spermatophoric sac mass (g) and gonad mass (g). Statoliths were dissected from a sample of 97 individuals for age determination and the stomach contents of 30 squid that had food in their stomachs were analysed.

The distribution and the abundance of *Martialia hyadesi* juveniles during the years 1988 and 1989 were analysed from data obtained during two research cruises directed at studying juvenile short-finned squid *Illex argentinus*. The Soviet R.V. *Evrika* performed a joint survey (USSR-Argentina) in the area between 35 and 50°S, offshore to 35°W, during August and September 1988 (Anon. 1989). Oceanographic observations and midwater trawls were made by day and night. A small midwater trawl net (13.7 m long), with a mouth area of 8 m<sup>2</sup> and a mesh size of 5 mm, was used. A total of 238

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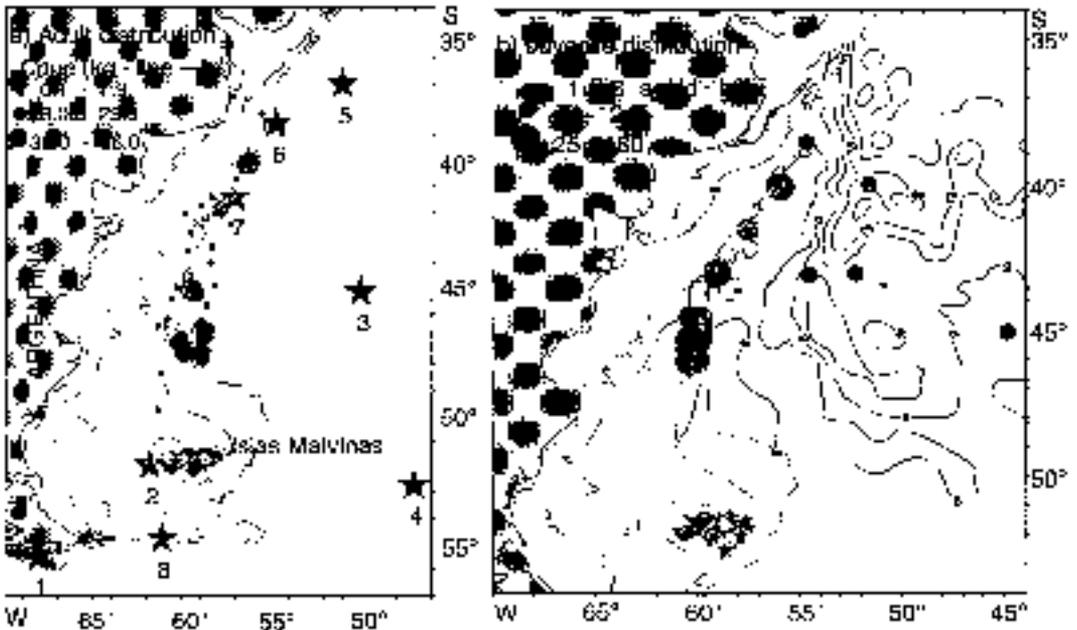


Fig. 1: (a) Distribution and abundance of adults in the 1995 fishing season (by *cpue*) and historical data on *Martialia hyadesi* catches in the South-West Atlantic according to the following list:

Position *	Source	Date	Number of individuals	ML (mm)
1	Rochebrune and Mabille (1889)	16/11/1882	1	301
2	Castellanos (1967)	15/7/1966	4	303 – 356
3	R.V. <i>Evrika</i> 1988	07/10/1988	1	330
4	Rodhouse (1991)	Feb. 1989	Commercial catches	170 – 280
5	R.V. <i>Kaiyo Maru</i> 1989	11/08/1989	1	300
6	R.V. <i>Kaiyo Maru</i> 1989	16/08/1989	1	348
7	R.V. <i>Kaiyo Maru</i> 1989	04/09/1989	1	280
8	R.V. <i>Oca Balda</i> 1995	17/11/1995	3	253 – 317

(b) Juveniles in relation to surface temperature (°C) during spring of 1988 and 1989 and historical data from Rodhouse *et al.* (1992a). Star refers to October–November 1990/91, ML 21–33 mm

oblique tows of 15–30 minutes duration was made at standard depths (50–0, 135–75, 200–150, 350–250 m). In addition, 53 bottom tows were made with a large pelagic trawl (70/370) on the outer shelf between 44°50' and 45°15'S.

Another joint survey (Japan-Argentina-Uruguay) was carried out by the Japanese R.V. *Kaiyo Maru* in August and September 1989 (Brunetti *et al.* 1990). That survey covered the Argentinian and Uruguayan shelves, as well as the continental slope and the open sea, between 35 and 45°S, and west of 50°W. A total of 69 oceanographic and 54 midwater trawl (*Kaiyo Maru* midwater trawl KMT, codend of 75 mm mesh with a liner of 10 mm mesh) stations was occupied at night. The KMT was hauled obliquely from near the bottom (up to 1 000 m) for 30 minutes.

In both cruises, squid from the catch were hand-

sorted, identified and weighed. The *ML* was measured to the nearest 1 mm and the sex and the gonadal maturity stages recorded.

## RESULTS AND DISCUSSION

### Distribution and general biology

Historical records of *Martialia hyadesi* catches in the South-West Atlantic are shown in Figure 1. Its distribution extends from a depth of 200 m off Argentina to 46°W in the adjacent deep ocean. Commercial catches have been made during February north-west of Shag Rocks (4) and between March and June off Argentina (Rodhouse 1991). Between July and

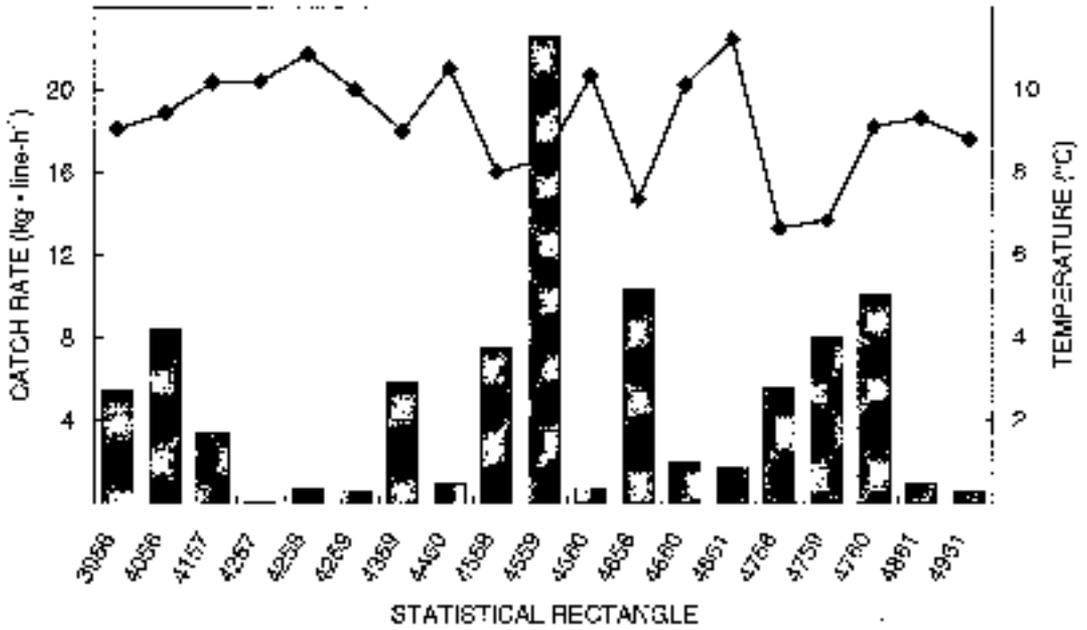


Fig. 2: Distribution of mean *cpue* and mean surface temperature (°C) by statistical rectangle during the 1995 fishing season (March–June)

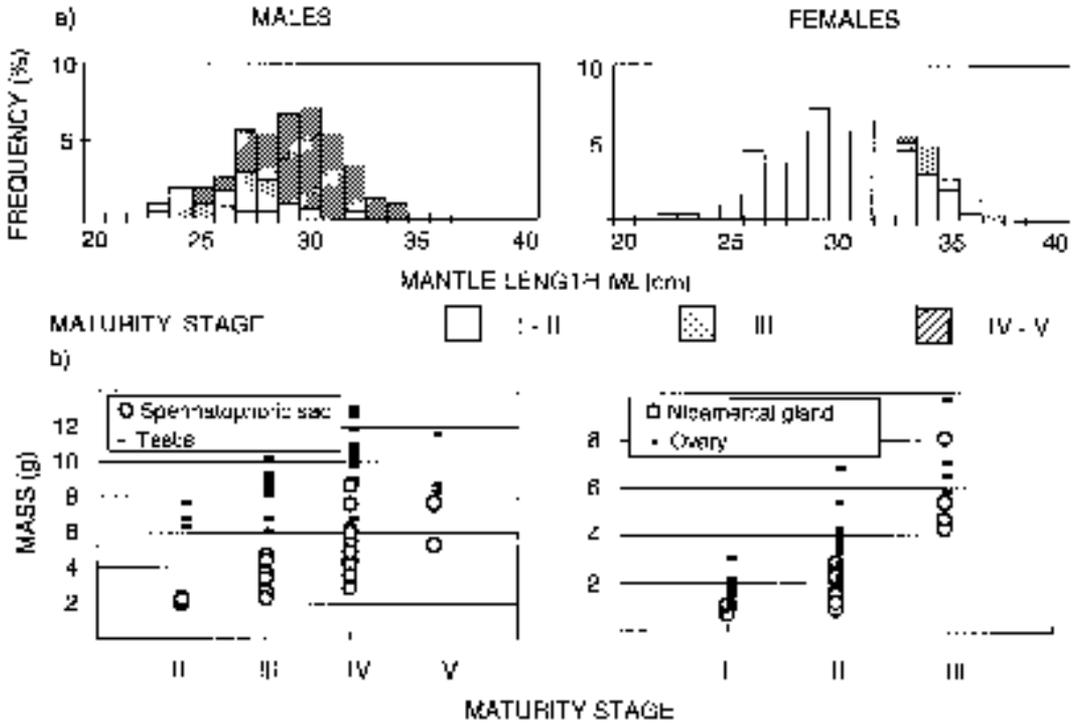


Fig. 3: (a) Distribution of mantle lengths and maturity stages by size of squid caught during the 1995 fishing season; (b) distribution of testis, spermatophoric sac, ovary and nidamental gland masses by maturity stage

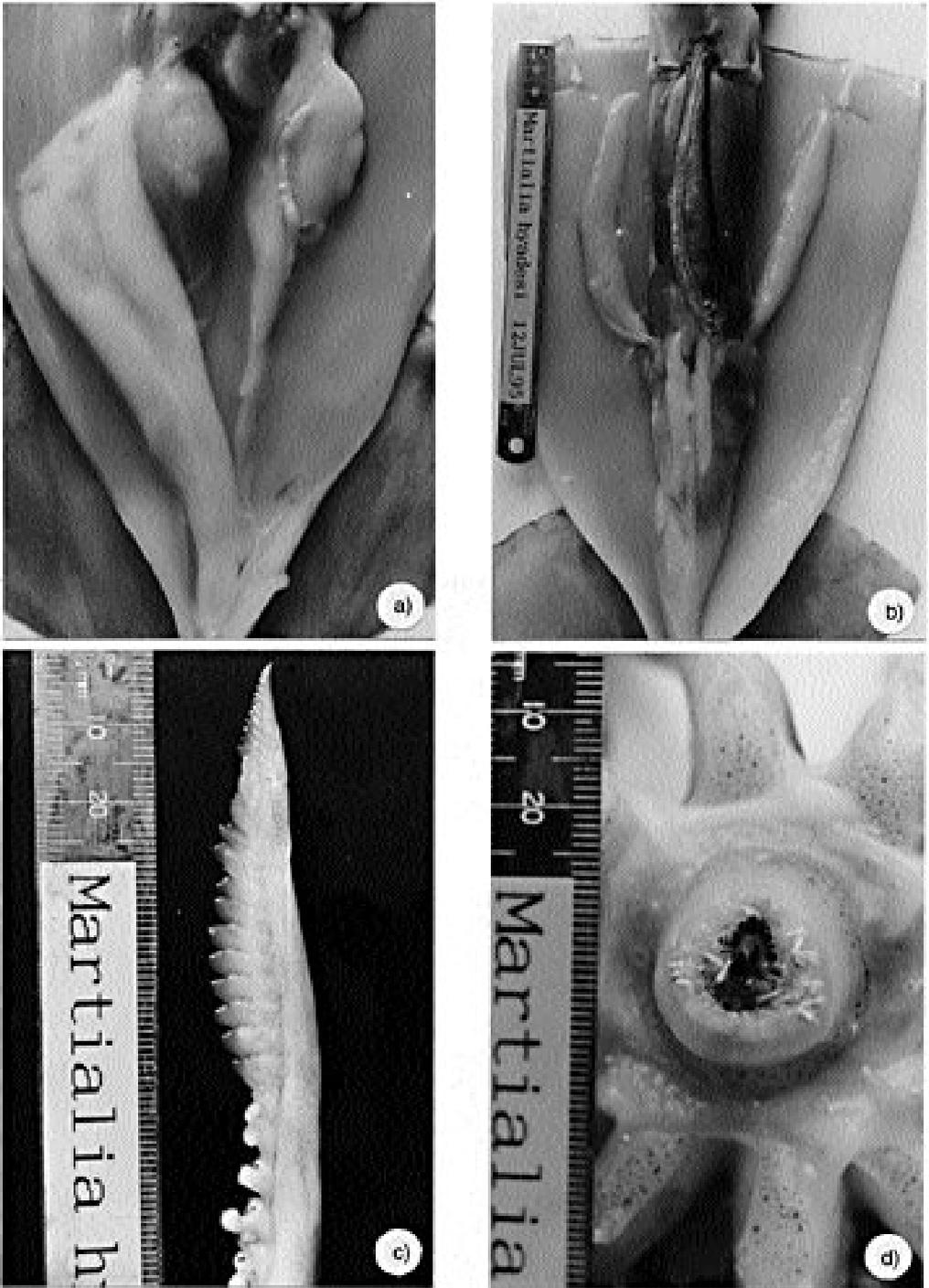


Fig. 4: Mature male (a; *ML* 288 mm) and its hectocotylus (c; Left Arm IV) and immature female (b; *ML* = 293 mm) with spermatophores attached to the buccal membrane (d)

November, a few adults have been caught during research cruises (1–3, 5–8).

During the 1995 *Illex argentinus* fishing season, 852 tons of *Martialia hyadesi* were caught by jigger vessels between March and June (*cpue* and catch positions in Fig. 1). The biggest catches were made during April and June. The species was captured on the outer shelf and slope, between 38 and 50°S. Two areas of great abundance were detected, one around 40°S (April–May) and the other between 45 and 48°S (April–June). In the latter, catches of up to 40 tons per day were obtained, particularly around 45°S, 59°W.

The relationship between mean surface temperature and mean *cpue* of the commercial fleet for each fishing rectangle shows that the species was caught when surface temperatures were between 6.8 and 11.7°C, with greatest abundance (8–22 kg·line·h<sup>-1</sup>) when surface temperatures were between 7 and 9°C (Fig. 2). From these water temperatures, it can be deduced that the species is distributed mainly in waters of the Malvinas Current. Rodhouse (1991) also related the unusual abundance of the species over the Patagonian slope during 1986 with an exceptional incursion of cold water that year.

The size of the squid caught commercially ranged between 221 and 375 mm *ML* (Fig. 3). Females were larger than males (male mean *ML* 291.95 mm, *SD* = 25.40 mm, *n* = 130; female mean *ML* 305.50 mm, *SD* = 31.42 mm, *n* = 164), but males attained sexual maturity earlier than females.

Larger than 250 mm *ML*, most males (57%) were almost mature (Stage IV) and 13% were mature (V), with well developed spermatophores in the spermatophoric sac and more than 35% of Arm IV hectocotylized (Fig. 4). Such males were capable of copulation, judging by the presence of fertilized females. A further 26% of the males were maturing (III) and 4% were immature (II). Of the females, 90% were immature (I–II), 15% having copulated, with spermatophores implanted in the buccal membrane (Fig. 4). Larger than 300 mm *ML*, some females were maturing (III), but only one was mature (IV, 333 mm *ML*). There was an increase in the masses of the nidamental gland, spermatophoric sac and gonad with maturity stage (Fig. 3). If the presence of mated females is taken to reflect the onset of maturity and reproductive migration, as was observed in *Todarodes pacificus* (Okutani 1983), the *M. hyadesi* would have been at the beginning of such events. Nigmatullin (1989) postulated that the species spawns over the continental slope during spring, and according to Rodhouse (1991) west of the Scotia Sea.

Juveniles were distributed in waters of the Patagonian slope and in the adjacent oceanic region during August and September of 1988 and 1989 (Fig. 1). They were found mainly in waters of the Malvinas Current (salinity  $33.9\text{--}34.1 \times 10^{-3}$ ; temperature 5–7°C), but

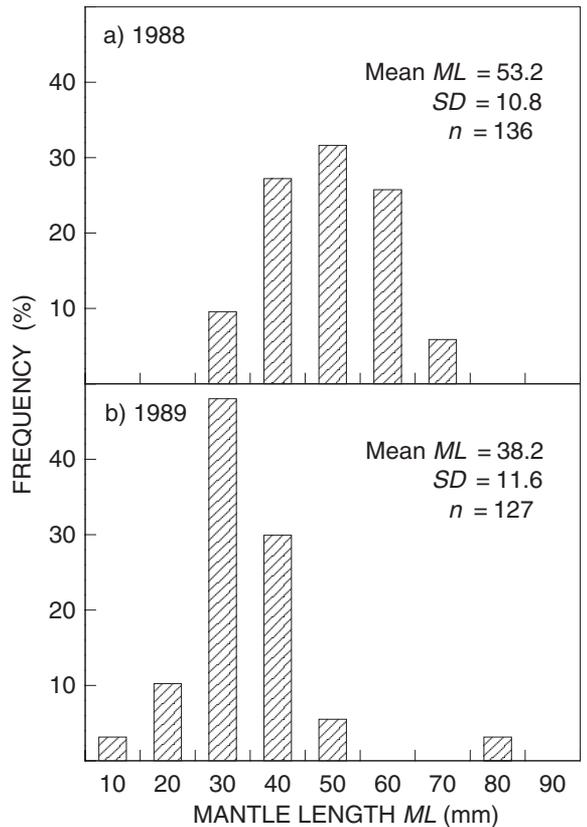


Fig. 5: Distribution of mantle lengths of juveniles caught during August and September of (a) 1988 and (b) 1989

they were also observed in mixed waters (10–11°C) of the Brazil-Malvinas Confluence (Brunetti *et al.* 1990). The largest catches were made between 0 and 50 m deep. The size ranged between 15 and 81 mm *ML*, although the mean sizes in 1988 were greater than those of 1989 (Fig. 5). Juveniles (21–33 mm *ML*) were found north and east of the Malvinas Islands during October and November by Rodhouse *et al.* (1992a), and individuals of almost the same size (12–27 mm *ML*) were found in the stomach contents of the adults caught during June 1995.

### Hatching months

The ages of the squid caught commercially ranged between 188 and 307 days (assuming one “increment” in the statolith per day), signifying that they had hatched between August and November, with a maximum in the last month (Fig. 6). A similar situation

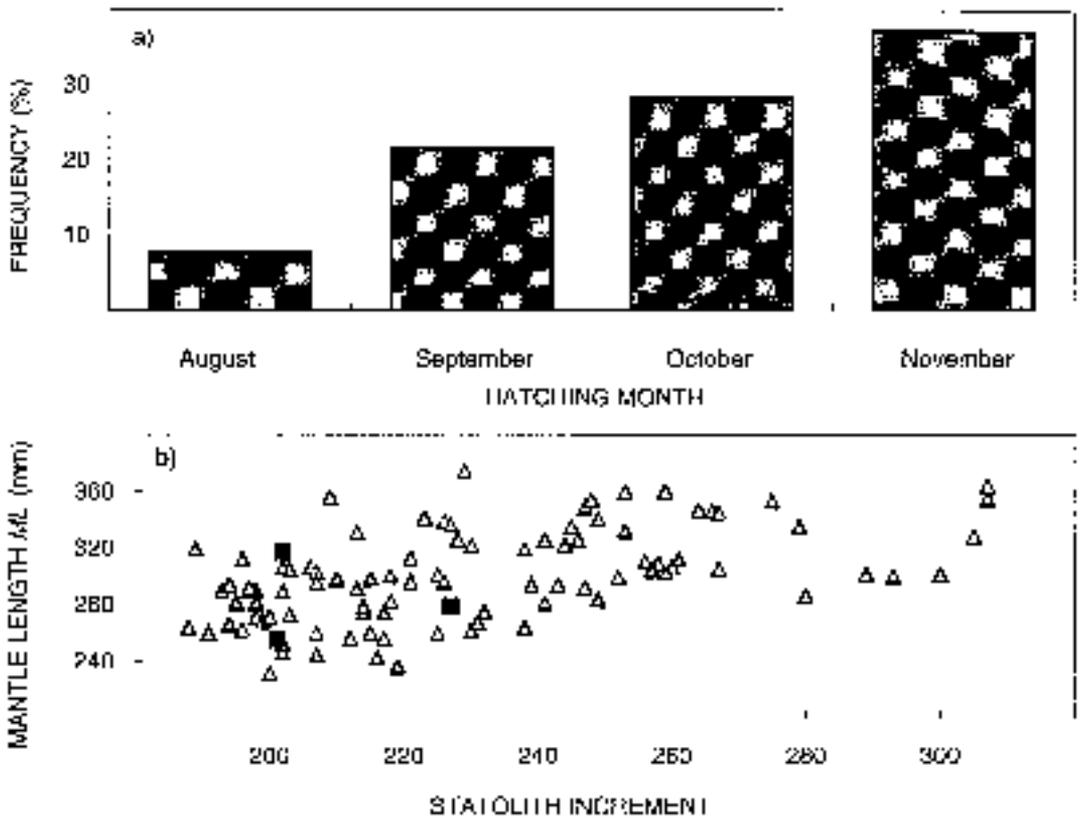


Fig. 6: (a) Distribution of hatching months and (b) relationship between mantle length and the number of statolith increments for squid caught during the 1995 fishing season (triangles) and three specimens caught during November of the same year (squares)

was reported by Rodhouse *et al.* (1994) for squid caught on the edge of the Patagonian shelf (Rectangle 4759) in 1989. Those squid had hatched between September and January, with a maximum in October. Mean sizes and maturity stages of both sexes were also similar for both studies, supporting the hypothesis that a spring-hatched group of *Martialia hyadesi* is distributed on the outer Patagonian shelf, at least between 38 and 50°S during winter.

The ages of three individuals caught during a research cruise on the outer shelf at 55°S in November 1995 ranged between 201 and 227 days (size range 255–317 mm ML), the hatching months being May and June. This contrasted with the hatching period mentioned above (August–November), but it agreed with that of squid caught at the Antarctic Polar Front (north-west of Shag Rocks) and reported by Rodhouse *et al.* (1994) as a winter-hatched group. On the other hand, two juveniles of 42 and 43 mm ML caught in

September 1989 on the outer Patagonian shelf (46°S) were 137 and 150 days old respectively, having hatched in April. Even though those juveniles were in the same area as the spring-hatched adults, they seemed to be related to the winter-hatching group. The same could be said for the small juveniles found in June in the stomach contents of the adults.

## Diet

Fish represented 43.9% of the total food analysed, and 90% of the fish were identified as belonging to the two myctophid species *Protomyctophum tenisoni* (75%) and *Gymnoscopelus nicholsi* (15%). Squid accounted for 36.6% of the diet, 70% being *Martialia hyadesi* and the balance belonging to small oceanic species that could not be identified. According to a size analysis of the beaks and statoliths, 80% of the

squid eaten were small juveniles of the same species (12–27 mm *ML*) and the balance squid of similar size to that of the predator. Zooplankton constituted 19.5% of the food, 70% amphipods and the rest euphausiids. *Primno macropa*, a typical oceanic amphipod species, represented 71.4% of the amphipods, the remaining portion being *Themisto gaudichaudii*.

In terms of number of prey types ingested, only one type had been eaten by 60% of the squid analysed, 33.3% had two types of prey in their stomachs and 6.7% had consumed all three categories. The most frequent association of two types of prey was that of fish and squid.

The diet of adults (194–302 mm *ML*) caught at the Antarctic Polar Front (north of the Scotia Sea) was documented by Rodhouse *et al.* (1992b). They concluded that the diet was mainly myctophids (*Krefflichthys anderssoni* and *Electrona carlsbergi*) and, in a lesser proportion, euphausiids (*Euphausia superba*) and amphipods. Some cannibalism was also detected.

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